National Park Service
U.S. Department of the Interior

Joshua Tree National Park

Environmental Assessment
Fire Effects Research Study

Proposed Action:
As part of a larger study, the Western Ecological Research Center of the USGS proposes to treat two study sites across the Mojave Desert, in the southwest and in the northeast, to represent possible regional variation and to provide information for localized areas where fires are a recognized problem for land managers. Both sites would be located in areas containing blackrush scrub and invasive annual grassland. Blackbrush scrub includes emergent Joshua tree, *Yucca brevifolia*, and California or Utah juniper, *Juniperus californica* or *Juniperus osteosperma*, with invasive annual grasses in the interspaces between shrubs.

For further information, please leave your contact information at 760-367-5502.

Note to Reviewers and Respondents:
If you wish to comment on this Environmental Assessment, you may mail comments by August 25, 2003, to Superintendent, Joshua Tree National Park, 74485 National Park Drive, Twentynine Palms, CA 92277, Attn: Fire Effects Study.

Comments submitted by electronic mail may be addressed to jotr_publiccomments@nps.gov and will be accepted through August 25, 2003. Please reference "Fire Effects Study" in the subject line.

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1 Introduction

1.1 Purpose and Need

In the Mojave Desert, fire appears to be historically rare, plant communities are generally slow to recover from fires, and fires often increase landscape flammability due to postfire dominance of invasive annual grasses. Fuel models have not been developed for Mojave Desert vegetation types, so fire behavior can be difficult to predict. Additional data are needed to determine the behavior and effects of fire in blackbrush and intermixed invasive grasses, and to develop techniques to minimize its impact and reduce the dominance of invasive annual grasses in the Mojave Desert. With such information, agency land managers would be able to apply the data and the techniques to management programs intended to reduce fire hazards created by blackbrush and invasive grasses, especially at urban wildland interfaces, while at the same time preserving the natural resources that public agencies are mandated to protect.

The Western Ecological Research Center of the United States Geological Survey (USGS) has requested that the National Park Service (NPS) assist with research efforts by treating a small plot of land in Lower Covington Flats of Joshua Tree National Park, California. They have requested a plot of land that contains a blackbrush-dominated vegetation community in order to test current hypotheses and better understand the impacts of fire and chemical disturbance on blackbrush and associated species (see Attachment 7.1, Study Plan, May 20, 2003). Fires have been frequent in this region recently and have destroyed large expanses of vegetation dominated by blackbrush, creosotebush, and Joshua trees. The invasive annual grassland at this site was created after a prescribed fire in 1993. The objectives of the research effort within the blackbrush community are as follows:

- Compare fire behavior of blackbrush and invasive annual grassland vegetation and gather data to help develop custom fuel models for these vegetation types.
- Evaluate the effects of spring fire, summer fire, and blackbrush thinning on post-treatment fuel loads.
- Evaluate the effects of spring fire, summer fire, and herbicide treatments on post-treatment dominance of invasive annual grasses.
- Evaluate the effects of pre-fire nutrient status on post-fire dominance of invasive annual grasses.
- Document the ecological effects of a short fire-return interval.
- Document the ecological effects of spring fire, summer fire, blackbrush thinning, and herbicide application on plant populations and communities and on soil nutrient levels.
- Compare the cost-effectiveness of spring burning versus herbicide applications for reducing fine fuel loads and controlling invasive annual grasses.
- Develop a biophysical model describing the relationships between burning conditions and postfire effects on vegetation, soil seed banks, and soil nutrient levels.
- Develop educational materials and establish the field site as one of two demonstration sites of the effects of alternative management treatments for the reduction of fuel loads and the control of invasive annual grasses.
- Develop a long-term monitoring protocol to evaluate the effects of treatments over multiple years.

1.2 Background and Previous Planning

In May 1999, a planning meeting was conducted to determine the validity of the goals and objectives of the fire management program in Joshua Tree National Park. The NPS Pacific West Regional Fire Management Officer and Regional Fire Ecologist attended this meeting along with members of the Park Staff. It was determined that the objectives listed in the 1992 Fire Management Plan were sound but that wildland fire use for resource benefits would be limited to a smaller size and in areas outside of the Quail Mountain watershed. Three weeks later the lightning-caused Juniper Complex became the largest fire occurrence in the Park's history and the Superintendent directed all future fires to be suppressed, regardless of cause, until long term effects of wildland fires in the desert can be determined. Park scientists have discovered that more of the blackbrush and Joshua Tree communities were burning faster than could be replaced in the natural cycle.

In January 2001, another planning meeting was conducted at the Black Rock Interagency Fire Center. This meeting was comprised of an interagency audience from the Bureau of Land Management, National Park Service and USGS, Biological Resources Division, Western Ecological Research Center. This is considered to be the first internal scoping session in which pertinent issues were identified. Dr. Matt Brooks, USGS Research Botanist, compiled all our concerns and proposed to study Fire Behavior, Fire Effects, and Fuel Management in Blackbrush (Coleogyne ramosissima) Shrublands and Invasive Annual Grasslands of the Mojave Desert (see Attachment 7.1, Study Plan, May 20, 2003).

In the spring of 2001, USGS, through its Western Ecological Research Center, Las Vegas Field Station, conducted baseline studies comparing burned and unburned blackbrush vegetation on sites in Utah, Nevada, and California. Results of the studies were reported by the USGS in December of 2001 in a report titled "Plant Community Patterns in Unburned and Burned Blackbrush (Coleogyne ramosissima) Shrublands in the Mojave Desert" (Brooks and Matchlett 2001). The report was the first product of a larger research project designed to examine fire behavior and ecological effects in blackbrush shrublands and invasive annual grasslands in support of resource management programs of the NPS, Pacific West Region, and other land management agencies in the southwest United States. The studies provided essential data for the development of follow up research that would apply experimental fire and herbicide treatments to two of the sites in order to increase understanding of fire behavior in blackbrush, document the ecological effects, and provide answers to important questions concerning how to manage native and invasive non-native plant species in such environments. The project analyzed in this environmental assessment is comprised of that follow up research for the study site in Joshua Tree National Park at Lower Covington Flats.

Starting in January 2002, managers at Joshua Tree National Park have conducted lengthy public scoping, and in doing so, have determined that the public would also like to know the answers to the questions presented in this study.

1.3 Derivation of Impact Topics

To provide a focus for environmental discussions, and to ensure that alternatives are compared on the basis of the most relevant topics, the impact topics presented below were selected. These impact topics were identified based on federal laws, regulations, and orders; 2001 NPS Management Policies; and NPS knowledge of easily impacted resources. A brief rationale for the selection of each impact topic is given below, as well as the rationale for dismissing specific topics from further consideration.

1.3.1 Included Impact Topic: Biotic Communities

The National Environmental Policy Act (NEPA) mandates an examination of each proposed action's impacts on all components of affected ecosystems. NPS policy is to protect the abundance and diversity of the park's naturally occurring communities. Prescribed fire, use of herbicides and mechanical thinning presents potential impacts to native plant communities and vertebrates. Therefore, this Environmental Assessment (EA) will examine the impact to biotic communities of the proposed action and its alternatives.

1.3.2 Included Impact Topic Species of Concern

The Endangered Species Act of 1973 mandates an examination of impacts on all species on the federal list of threatened or endangered species. A federally listed species is potentially affected by the proposed action: the desert tortoise (Gopherus agassizii). The Lower Covington Flats area of Joshua Tree National Park has a particularly low population of the desert tortoise; this EA must assess the potential impacts of the proposed action to tortoises that may be in the area. Other wildlife species whose habitat that would be affected includes the silvery legless lizard (Anniella pulchra pulchra), and the scrub jay (Aphelocoma coerulescens).

1.3.3 Included Impact Topic Cultural Resources

The National Historic Preservation Act of 1966 (as amended), NEPA, NPS Management Policies, NPS-2 (Planning Process Guideline), and NPS-28 (Cultural Resource Management) call for the consideration of archeological resources in planning proposals. Lower Covington Flat contains few known prehistoric or historic archeological sites, despite five archeological surveys in the area. Only one known historic archeological site (CA-SBR-7651H) is in the immediate vicinity of the project area.

1.3.4 Dismissed Impact Topic: Wilderness Experience

The NPS wilderness management policies are based on statutory provisions of the Organic Act of 1916, the Wilderness Act of 1964, and legislation establishing individual units of the national park system. Joshua Tree National Park is a unit of the National Wilderness Preservation System, a site designated by Congress and legally protected as wilderness in perpetuity. The 2001 NPS Management Policies require the administration of NPS-managed wilderness areas for the use and enjoyment of the American people in such a manner that will leave them unimpaired for future generations. Study plots in this proposal are outside of designated wilderness boundaries.

1.3.5 Dismissed Impact Topic: Scenic and Recreational Values

Providing for visitor enjoyment is one of the fundamental missions of the NPS, according to the Organic Act of 1916 and the 2001 NPS Management Policies (2001). The proposal to study long-term fire effects in an area already devoid of vegetation from previous fires will not detract from the visitor experience.

1.3.6 Included Impact Topic: Air Quality

The Clean Air Act of 1970 (as amended 1990) requires federal land managers to protect park air quality. NPS Management Policies call for air resource management to be integrated into NPS operations and planning, and for all air pollution sources within parks to comply with federal, state, and local air quality regulations. The generation of small amounts of particulates emitted by burning hot flashy fuels will be considered by this EA. During scoping, the public was concerned about the health effects of smoke during the study and also the effects of aerosol herbicide spraying.

1.3.7 Included topic: Visitor Experience

Visitors will observe smoke from fires burning in the treatment sites. This may result in concerns from the public about threats to Park resources.

1.3.8 Dismissed Impact Topic: Socioeconomic Issues

Tourism associated with Joshua Tree National Park, currently averaging 1.25 million visitors each year, is economically important to the communities surrounding the park. Hotels, restaurants, grocery stores, and specialty shops cater to the different users of the park, including rock climbers, sightseers, campers, and equestrians. With 270 miles of trails and trail corridors already utilized by park visitors, the proposed action and its alternatives would not significantly affect the visitation to Joshua Tree National Park; therefore, socioeconomic issues will not be evaluated further in this EA.

1.3.9 Dismissed Impact Topic: Environmental Justice

Executive Order 12898, "General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their policies on minorities or low-income populations and communities. Neither the proposal nor its alternatives would have health or environmental effects on minorities or low-income populations or communities; therefore, this topic will not be analyzed by the EA.

1.3.10 Dismissed Impact Topic: Water Quality

Quality and quantity of both ground and surface water remain a point of concern in the high desert environment that encompasses Joshua Tree National Park. Naturally occurring surface water is rare in the park. There are more than 120 known water sources, including springs, seeps, wells, and one short perennial stream. There are no springs, tanks, seepages or wells within the immediate area and because there are no water resources directly affected by this action, it will not be examined further in this EA.

2 Proposed Action and Alternatives

2.1 Alternative A—No Action

No treatments or research would occur in the blackbrush ecosystem in this area. Currently approved management actions would be maintained under this alterative. The area would continue to be managed under existing full suppression plans. Descriptions of existing management from these various plans are found in the Fire Management Office of the Joshua Tree National Park. None of these existing plans contains management guidance that specifically address blackbrush ecosystems. Routine land management practices would continue with this alternative but none currently dealing with blackbrush ecosystem health issues.

2.2 Alternative B—Proposed Action

As part of a larger study, the Western Ecological Research Center of the USGS proposes to treat two study sites across the Mojave Desert, in the southwest and in the northeast, to represent possible regional variation and to provide information for localized areas where fires are a recognized problem for land managers. Both sites would be located in areas containing blackbrush scrub and invasive annual grassland. Blackbrush scrub will include emergent Joshua tree, *Yucca brevifolia* and California or Utah juniper, *Juniperus californica* or *Juniperus osteosperma* with invasive annual grasses in the interspaces between shrubs.

This EA looks at the impacts of treating one site in Joshua Tree National Park, California, on public lands administered by the National Park Service (see Figure 8.1, Research Plots). The proposed site is located in Zone 11,T1S, R6E, Section 26, at approximately 4600 feet above mean sea level. The site was selected because it contains the necessary vegetation, is on a gentle slope, is accessible from existing roads, and would not be visible to visitors traveling the main roads in the area (Figure 8.1, Research Plots).

The complete study plan is described in Attachment 7.1. Vegetative treatments comprised of prescribed fire, herbicide application, and mechanical thinning would be applied to six study plots totaling approximately 65 acres within the 160 acre study area. Approximately 40 acres would be burned, 10 acres of blackbrush would be thinned by 50 percent, 10 acres would be treated with a chemical herbicide, and up to five acres could be impacted through the construction of fire line and black line. Fire line would involve the physical removal of organic material above ground. Using hand tools such as shovels, McClouds and Pulaskis, the fire line is proposed to be three feet (one meter) wide and would surround the burn sites. Black line would be created using fire to remove above ground organic material. The black line would also surround the burn sites, and could be as wide as 30 feet (10 meters). Study plots would be large enough (200 by 200 meters each) to document fire behavior and allow researchers to evaluate fire, mechanical, and herbicide effects at multiple spatial scales within each treatment plot (see Figure 8.1, Research Plots).

Plots scheduled for burn treatments or used as unburned controls will receive a 25 meters, pre-fire nutrient treatment consisting of nitrogen (NH_4NO_3), phosphorous (K_2PO_4), carbon ($C_6H_{12}O_6$), or carbonate ($CaCO_3$) or left untreated as a control.

Dirt roads and natural barriers would be complemented with a 1 meter hand constructed fire line and, where necessary, a 10 meter black line around each treatment plot. Water and/or foam would be used to wet down fuels surrounding the plots. This would prevent the experimental fires from escaping and becoming wildfires. Fire personnel would write the burn plan and conduct the fires.

Fire treatments would be applied in spring and summer 2004 or 2005, generally between May and September. Timing will depend on weather, burn indices, and other conditions described in the burn plan for the site. Seasonal fire treatment plots would be burned

during the same or consecutive days in the blackbrush and invasive annual grassland portions of each site. A burn plan would be prepared in accordance with NPS standards prior to ignition. Sufficient fire suppression resources would be on site to monitor the burn and to prevent escape of the fire into the surrounding area.

The fires would be started by igniting all vegetation in a strip along the upwind border of each plot with a drip-torch, and letting it spread as a headfire through the fire treatment plot. Each fire would be allowed to extinguish naturally on its own within each treatment plot, but the spread of fire outside of the plots would be prevented by fire crews using hand tools, water, or foam at the discretion of the burn boss. In the event that burns are not completed in any given year due to conditions being outside of burn prescriptions, other treatments would continue as planned at the discretion of the researchers.

Herbicide treatments would be applied during spring 2004 on the same or consecutive days in the invasive annual grassland portions of each site. Glyphosate (RoundUp) would be applied at a rate of 10 ounces per acre, well below rates known to damage non-target, perennial plants. All state and federal rules pertaining to application of the chemical would be followed.

There would be no new road construction or upgrading as part of this project. The only surface disturbance would result from the construction, by hand of up to two miles (three feet wide) of fire line and up to 65 acres from the vegetative treatments. Vehicles would park on existing roads/disturbed areas.

All prescribed fire operations would be conducted in accordance with National Park Service Fire policy and all pertinent rules and regulations. Firefighter and civilian safety is the number one priority. Burns would be coordinated with air quality regulators of the Mojave Air Quality Management District in order to ensure that air quality thresholds are not exceeded. Local fire and government officials and affected local communities would be notified of planned operations in advance of ignition to avoid unnecessary public reaction to smoke columns.

Research Schedule: Dates are subject to change depending on weather and site conditions. Continued drought could result in only portions of the study being completed at either of the two study sites.

Fiscal Year 2000
Develop study plan
Identify study areas
Purchase equipment

Fiscal Year 2001 and 2002 (treatments delayed until Fiscal Year 2003 due to drought)
Establish experimental plots at Joshua Tree National Park and on the Beaver Dam Slope of the St. George Field Office BLM, in alien annual grassland (previously burned blackbrush) and unburned blackbrush
Collect pre-treatment plant data
Write burn plan and obtain biological and cultural clearances

Fiscal Year 2003 (only blackbrush thinning applied this year, other treatments delayed due to drought)
Collect pre-treatment soil seedbank samples early Fall
Grow out seedbank samples and identify species during Winter
Collect pre-treatment data in Spring
Apply blackbrush thinning in the blackbrush shrubland in Spring
Collect blackbrush fuel samples to develop cover vs. biomass regression models in Spring
At the beaver dam site, apply fire treatments in the blackbrush shrubland and document fire behavior and intensity in spring and summer
Analyze pre and post-fire soil nutrients and seedbanks to establish immediate fire effects on nutrient availability and seed viability

Fiscal Year 2004 (plan to apply all other treatments if rainfall produces a substantial crop of invasive grasses)
Collect soil seedbank samples (post-treatment blackbrush thinning and control plots; pre-treatment all other plots) early Fall 2003
Grow out seedbank samples and identify species during Winter
Apply herbicide treatments in the invasive annual grassland in Spring
Apply fire treatments in the blackbrush shrubland and document fire behavior and intensity in spring and summer
Apply fire treatments in the invasive annual grassland and document fire behavior and intensity in spring and summer
Analyze pre and post-fire soil nutrients and seedbanks to establish immediate fire effects on nutrient availability and seed viability
Collect post-treatment (blackbrush thinning and control plots) plant measurements in the early Spring

Fiscal Year 2005
Collect post-treatment soil seedbank samples early Fall
Grow out seedbank samples and identify species during Winter
Collect post-treatment plant measurements in the early Spring

Fiscal Year 2006
Collect post-treatment soil seedbank samples early Fall
Grow out seedbank samples and identify species during Winter
Collect post-treatment plant measurements in the early Spring
Establish long-term monitoring protocol
Complete final report

Information on fire behavior and the first year effects of fuel management treatments would be reported at the end of fiscal year 2004. Evaluations of fuel conditions and fire behavior would be developed by the end of fiscal year 2005. A final report would be completed by the end of fiscal year 2006. Preliminary data would be reported annually to federal land managers in the Mojave Desert. Researchers may also provide stakeholder tours of the sites, and coordinate a regional workshop on the ecology and management of fire and invasive plants in the Mojave Desert in fiscal year 2005 depending on stakeholder and agency interest and concerns. Researchers expect to publish approximately six journal articles using these data, in addition to fact sheets and press releases that focus on specific management issues. The principal investigators would continue to provide technical assistance on fire management issues for federal land management units in the Mojave Desert.

2.2.1 Mitigation of the Effects of the Proposed Action

Mitigation measures are analyzed as part of this proposal. These actions have been incorporated into the proposal to lessen the impacts of the proposal. These measures will be applied to the proposed action or to any other alternative selected to the appropriate degree.

Mitigation measures would be strictly enforced to protect tortoises, if tortoises are present. There would be a negligible, adverse, short- and long-term impact to desert tortoises from the proposed action. Two mitigations measures required by USFWS are:

1. Treatment plots scheduled for herbicide spaying will be fenced off prior to spraying to prevent any potential 'take' of tortoises. This fencing would remain in place until toxicity subsides enough not to pose a threat to wildlife.

2. The fireline to be constructed around the study area (up to 2 miles long, 3 feet wide) will become a revegetation project with the goal being to reconstruct the natural spacing, abundance, and diversity of native plant species. If it is determined the fireline cannot be adequately restored then the park will identify an area elsewhere for restoration that is no less equal in size to the disturbed area.

2.2.1.1 Cultural Resources

Surface identification and mapping of any directly, or indirectly, impacted cultural resources have been conducted. An archeologist would flag the boundaries of the CA-SBR-7651H archeological site prior to any activity in the project area and the site would be avoided. Flagging would be removed at the conclusion of the project.

2.2.2.2 Desert Tortoise

The proposed project would take place in Mojave desert tortoise, *Gopherus agassizii*, habitat.

The NPS shall designate a field contact representative (FCR) who will be responsible for overseeing compliance for the desert tortoise. The FCR will coordinate with the U.S. Fish and Wildlife Service (FWS) and be authorized to halt any activity that may endanger desert tortoises. Only the biologist authorized by FWS shall be allowed to handle/relocate desert tortoise.

By maintaining existing management, a model of blackbrush ecosystem health, as a means of monitoring conditions, would not be created at this time. Additionally, the National Park Service would not gain any additional understanding of fire behavior in blackbrush.

2.3 Alternatives Considered but Eliminated From Detailed Analysis

Numerous alternative sites were evaluated during the development of the study design including sites in southern Nevada, northwestern Arizona and BLM lands outside the park. None of the other potential sites provided as safe or environmentally appropriate locations for meeting the objectives of the study as the site chosen for the Proposed Action. The proposed site is at a desirable elevation, is superior in achieving maximum range within the Mojave Desert blackbrush community, has an optimum mix of vegetative types including an area of burned blackbrush invaded by annual grasses, and has other physical and biological characteristics that make it ideal for successfully completing the study objectives. Thus none of the other sites are carried forward for further analysis.

2.4 Summary of Environmental Consequences

Impact Topic	No Action Alternative	Proposed Alternative
Biotic Communities	The effects of the no action alternative on biotic communities would be adverse, negligible to minor in intensity, and long term. Current trends would continue to occur and questions relating to proper management of fire in blackbrush ecosystems would remain unanswered.	Some habitat would be lost as a result of research activities, even with the mitigation of vegetative rehabilitation. The current trend is for portions of the area in and around the site to burn every few years. The relatively small size of the plots in relation to the size of the recent fires and remaining intact blackbrush community indicate that the proposal would not have a significant impact on vegetation.If the preferred alternative were to be implemented, there would be negligible, adverse, short-term and long-term impacts to biotic communities
Species of Special Concern: Desert Tortoise	The effect of the no action alternative on desert tortoises would be negligible.	There are no live tortoises or recent tortoise sign immediately within the area that would be impacted by experimental burns, herbicide, or blackbrush thinning treatments. The burrows found within the SE section of the experimental plots and within the 1200 foot buffer zone are approximately three years or older. The impacts to tortoises from the proposed action would be short-term and negligible to minor in intensity.

Impact Topic	No Action Alternative	Proposed Alternative
Cultural Resources	There would be no effect on cultural resources resulting from the no action alternative.	There would be no direct impacts to cultural resources from implementing the proposed action. The mitigation of flagging the boundaries of nearby CA-SBR-7651H would ensure a negligible direct or negligible cumulative impact to cultural resources.
Air Quality	The trend towards increasingly poor air quality in the region would not be altered by the no action alternative.	There would be a release of smoke during the burning of the plots during the spring and summer burn treatments, adding to the cumulative effects of air quality in the region. Due to the small acreage being burned, the proposed action would not cause air quality thresholds for the Mojave Air Quality Management District to be exceeded. The effect of the proposed action on air quality would be minor, adverse, and short term.
Visitor Experience	There would be no negligible impacts to visitor experience resulting from the no action alternative.	The short-term effect to visitor experience of the proposed action would be adverse and moderate in intensity. Any long-term effects to visitor experience would be negligible, as the burn study plots have been designed to blend in with the existing burn scars from recent wildland fires.

2.5 Environmentally Preferred Alternative

In accordance with DO-12, the NPS is required to identify the "environmentally preferred alternative" in all environmental documents. The environmentally preferred alternative is determined by applying the criteria suggested in the National Environmental Policy Act (NEPA) of 1969, which is guided by the Council on Environmental Quality (CEQ). The CEQ provides direction that "[t]he environmentally preferable alternative is the alternative that would promote the national environmental policy as expressed in Section 101 of NEPA, which considers:

1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations; 2. assure for all generations safe, healthful, productive, and esthetically and culturally pleasing surroundings; 3. attain the widest range of beneficial uses of environment without degradation, risk of health or safety, or other undesirable and unintended consequences; 4. preserve important cultural and natural aspects of our natural heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice; 5. achieve a balance between population and resource use that would permit high standards of living and a wide sharing of life's amenities; and 6. enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Generally this means the alternative that causes the least damage to the biological and physical environment. It also means the alternative that best protects, preserves, and enhances historic, cultural, and natural resources." (Council on Environmental Quality, "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations" [40 CFR 1500-1508], Federal Register Vol. 46, No. 55, 18026-18038, March 23, 1981: Question 6a.).

The no action alternative would have no impact on the 160-acre study area; however, the no action alternative also represents an acceptance of the current low status of knowledge regarding desert fire regimes and the rapid introduction of exotic plants into

the park's biotic communities. This alternative would not fully achieve provisions 1,2,3, and 4 of Section 101 of NEPA. In particular, the impact of postponing studies of fire and its effects on exotic plant introduction would have long-term environmental management consequences.

The NPS preferred alternative would further the goals of provisions 1,2,3, and 4 by providing information that would contribute to effective long-term management decisions regarding the park's biotic communities resources, including endangered species such as the desert tortoise. Some habitat would be lost as a result of research activities, even with the mitigation of vegetative rehabilitation. The current trend is for portions of the area in and around the site to burn every few years. The relatively small size of the plots in relation to the size of the recent fires and remaining intact blackbrush community indicate that the proposal will not have a significant impact on vegetation. Any increase in annual invasive grasses will reflect the trend that is currently observed in the blackbrush community. The NPS has determined that the environmentally preferable alternative in this instance is the proposed action, since it goes the furthest in attaining the goals of Section 101 of NEPA.

3 Affected Environment

3.1 Location

Joshua Tree National Park occupies 794,000 acres of the Mojave and Colorado Deserts of Southern California, approximately 140 miles east of Los Angeles (NPS 1996). The park lies along the east-west transverse ranges of the Little San Bernardino Mountains. The southern boundary of Joshua Tree National Park follows the base of these mountains along the northern perimeter of the Coachella Valley; the Morongo Basin defines the north boundary. The park lies in San Bernardino and Riverside counties. It is accessible from the south via Interstate 10, and from the north via Highway 62.

The Lower Covington Flats area of Joshua Tree National Park is located in the southwest Mojave Desert in California. There is one access road to this area, which connects with La Contenta Road in the town of Yucca Valley. The potential study plots would be located in the northwest corner of Joshua Tree National Park approximately two miles south of the town of Joshua Tree.

3.2 Biotic Communities

During the past few decades fires have been very frequent, and one was very large (greater than 13,000 acres) in this area. The invasive annual grassland at this site was created after a prescribed burn administered by NPS in 1993 (Nolina III prescribed burn). Soils at the Joshua Tree location are sandy loams derived from alluvial granitic parent materials, with no apparent petrocalcic horizons near the surface (Brooks personal observation). Wildlife in the area includes, but is not limited to, mule deer, some species of passerine birds, Gambel quail, cottontail rabbit, gray fox, bobcat, mountain lion, several snake and lizard species, and small rodents typical of the Mojave Desert blackbrush community. The vegetation type in the Covington Flats area is a mosaic of unburned blackbrush, *Coleogyne ramosissima*, scrub and burned areas now dominated by invasive annual grassland. Blackbrush scrub includes emergent Joshua tree, *Yucca brevifolia* and California juniper, *Juniperus californica,* with invasive annual grasses in the interspaces between shrubs.

3.3 Species of Concern

The desert tortoise, *Gopherus agassizii,* is listed as a threatened species by the FWS (50 CFR 17.11 & 17.12). Joshua Tree National Park is a designated Desert Wildlife Management Area (DWMA) under the 1994 Recovery Plan for the desert tortoise (Section II.B and E). As a DWMA, the NPS implements recovery actions to provide for the long-term persistence of viable desert tortoise populations (FWS 1994). The primary threats to the tortoise, identified in the Recovery Plan, include loss of habitat, habitat degradation (exotic weeds), mining, grazing, off-road vehicle use, and urban sprawl.

Lower Covington was surveyed for the desert tortoise for a total of 48.75 man-hours from April 16 to May 23, 2002, by park wildlife biologist, Pedro Chavarria. The surveys were performed according to USFWS protocols as specified under informal consultation from the Carlsbad Field Office. The 100 percent survey area was determined by creating a polygon that enclosed all the proposed experimental and control blackbrush plots using a map provided by USGS Biologist Matthew Brooks. In addition, the roads leading to the experimental plots were surveyed at a 15-meter buffer.

All areas were surveyed for signs of tortoise presence, including burrows, scat and dead tortoises. The results for this survey note that tortoise sign was found within the survey boundaries at Lower Covington Although no live tortoises were found, a deteriorated burrow was found, and the skeletal remains of a juvenile tortoise were found within the experimental plot region. In addition, another type burrow was found close to the 1200-foot buffer zone around the proposed experimental plots.

3.4 Cultural Resources

Cultural resources in the region of Joshua Tree National Park may reflect as much as 11,000 years of human use and occupation. This generalization has been made in the park's general management plan (NPS 1996). Such a statement is based upon the work of National Park Service archeologists, as well as those outside the agency, some of whom have done contract work for the park.

Five archeological surveys have been conducted within two kilometers of the project area. Three transects of a random stratified sample survey based on vegetation zones (Warren and Schneider 1992, 1993, 2000) pass through, or near, the treatment plots in the invasive grassland portion of the project area. During the course of their survey one site, CA-SBR-7651H, was located and recorded in the project area (Schneider et al. 1991). Although plotted in the blackbrush study units, CA-SBR-7651H actually lies 16m outside of the boundary. This site is an historic trash dump composed of approximately 80-100 sanitary seam tin cans, glass fragments, and one broken plastic 78 speed record. It probably dates from around the mid-1900s.

A survey was conducted to the north of the project area for the removal of foundations in Whispering Pines (Fox 1994). No cultural resources were noted as a result of this survey.

Surface identification and mapping of any directly, or indirectly, impacted cultural resources have been conducted in the study area for this project. The boundaries of the CA-SBR-7651H archeological site prior to any activity in the project area and the site would be avoided. Flagging would be removed at the conclusion of the project.

Three Herptofaunal study units (#21, 22, 23) are mapped within two kilometers of the study area. Array #22 is plotted within blackbrush scrub treatment plot number 83 of the current project area (Queen and Keswick 1999); however, this array was not found within the survey area and was most likely slightly misplotted. There were no cultural resources located in any of these three units.

The north end of Covington Loop Trail (Heaney 2000) is located about 0.3 kilometers northeast of the project area. There were no cultural resources found along this portion of the trail. In February of 2003 the plots were surveyed in their entirety in preparation for the blackbrush study (Hinton 2003). CA-SBR-7651H was relocated outside the study area and four isolated artifacts noted. The isolates were three sanitary seam tin cans and one red/purple jasper flake. Hinton's document functions as the National Historic Preservation Act Section 106 documentation for the blackbrush study.

Cultural resource base maps at Joshua Tree National Park also revealed that one reported, but undocumented dump site lies within two kilometers of the study area. It is not in the project area and will not be affected.

In summary, there have been five archeological surveys within two kilometers of the project area. Only one archaeological site and four isolates were recorded as a result of this work. One reported potential site also lies within the two-kilometer radius of the project area.

3.5 Visitor Experience

There are two hiking trails in the Covington Flats area: a segment of the California Riding and Hiking Trail, and the Covington Crest Trail. There are also two equestrian trails in the immediate area. One of the main scenic attractions of the Covington Flats area is a stand of large Joshua trees, which would remain unaffected by the proposed action. Much of the remaining vegetation in the Covington Flats area was burned by the Juniper Complex Fire in 1999, and previously by the 1993 Nolina III prescribed burn.

4 Environmental Consequences

4.1 Introduction

This section describes and analyzes the environmental consequences associated with the alternatives. Subsequently, this environmental consequence's section is organized by alternatives. First, the effects of the no action alternative will be discussed, as these effects relate to each impact topic. Then, the effects of the proposed action will be discussed, as these effects relate to each impact topic. Pursuant to National Park Service policy, the potential for "impairment" of critical resources will also be evaluated in this section of the environmental assessment. The action is a scientific study. Scientific methodologies for measuring fire effects before and after the treatment upon vegetation, soils and wildlife are described in Fire Behavior, Fire Effects, and Fuel Management in Blackbrush (Coleogyne ramosissima) Shrublands and Invasive Annual Grasslands of the Mojave Desert (see Attachment 7.1, Study Plan, May 20, 2003).

4.2 Definitions

The following definitions are provided to standardize the type, context, duration, and intensity of impacts associated with the EA alternatives. "Impairment" is also defined to clarify the analysis. A timeline of past, present, and future NPS actions in the area was presented in Chapter 3 to accurately be able to assess the cumulative effects of the alternatives.

4.2.1 Type, Context, Duration, and Intensity

Potential impacts to biotic communities, species of special concern, cultural resources, and visitor experience are described in terms of type (are the effects beneficial or adverse), context (are the effects site-specific, local, or regional in scop), duration (are the effects short-term, lasting less than ten years, or long-term, lasting longer than ten years), and intensity (are the effects negligible, minor, moderate, or major).

4.2.2 Impairment

NPS Management Policies 2001 (2000) requires an analysis of environmental consequences to determine whether or not a potential action would impair park resources or values. A fundamental purpose of the national park system, as established by the Organic Act and reaffirmed by the General Authorities Act (as amended), is to conserve park resources for future generations. NPS managers must always seek to avoid, or to minimize to the greatest degree practicable, adverse impacts to park resources and values. Although Congress has given the NPS the management discretion to allow impacts to park resources when necessary and appropriate, that discretion is limited by a statutory requirement that any impacts resulting from a potential action would not constitute impairment.

Impairment is an impact that, in the professional judgement of the responsible NPS manager, would harm the integrity of park resources or values. Any impact may constitute impairment, but impairment is more likely to result from a severe, adverse impact upon a resource whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; (2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or (3) identified as a goal in the park's general management plan or other relevant NPS planning documents.

As directed by the NPS Management Policies 2001, this EA includes a determination on impairment for the following impact topics: biotic communities and cultural resources.

4.2.3 Cumulative Impacts

The Council on Environmental Quality (CEQ) regulations, which implement the National Environmental Policy Act of 1969 (42 USC 4321 et seq.), require assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are

defined as "the impact on the environment from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for all impact topics.

Cumulative impacts are defined as the consequences of implementing the proposed action, in combination with the impacts of all other past, present, and reasonably foreseeable future private, state, and federal actions in the area of the proposed action.

Past actions include the Nolina III prescribed fire in 1993, and the NPS policy of full suppression during the Covington Fire of 1995 and the 1999 Juniper Complex Fire. Significant large fire activity is likely to occur in a desert ecosystem that has demonstrated more frequent return intervals. Very little information is available on the impacts associated with fire effects in desert ecosystems. The cumulative impacts of both the proposed action and no action are largely unknown, hence the need for the study.

Fires will continue to occur, and a management strategy based on empirical data would be beneficial to the future of Joshua Tree National Park. There are no on-going or study fires in Joshua Tree National Park that would contribute to cumulative impacts within the park.

4.3 Environmental Consequences of No Action

No direct, immediate impacts would occur to the on-site resources evaluated in this EA. Current trends would continue to occur and questions relating to proper management of fire in blackbrush ecosystems would remain unanswered.

4.3.1 Biotic Communities

Failure to conduct this study would not provide managers the scientific data needed to make sound decisions. Blackbrush, emergent Joshua Trees (Yucca brevifolia) and California juniper (Juniperus californica) would continue to be destroyed by exotic grassland-fueled wildfires. This situation creates an undesirable ecological condition that in the long term could convert historical biotic communities into exotic annual grasslands.

4.3.2 Species of Special Concern – Desert Tortoise

There would be no immediate impacts to the threatened desert tortoise resulting from the no action alternative.

4.3.3 Cultural Resources

Under the no action alternative, no project-related ground disturbance would occur. Impacts to archeological resources would be non-existent. The no action alternative would not result in changes to the area, therefore there would be no contribution to the cumulative effect upon cultural resources. Impact of the no action alternative to cultural resources would be non-existent. The no action alternative would not result in direct impacts, indirect impacts, or cumulative impacts to identified cultural resources. There would be no impairment to park resources necessary to fulfill specific purposes identified in the park's enabling legislation or key to the cultural integrity of the park.

4.3.4 Air Quality

There would be no negative impacts on air quality; however, baseline data collected from the NPS Black Rock Air Quality Monitoring Station since 1993 indicates that the park has some of the worst air quality of any national park in the country. Average particulate nitrate concentrations (ug/m3) for 2001 are 1.25 as compared to Grand Canyon National Park is 0.36. Average particulate Sulfate (p-S04) concentrations (ug/m3) for 2001 was 1.45 as compared to Grand Canyon at 1.02. The second highest one-hour ozone concentrations were 100 ppb. as compared to Grand Canyon at 70 ppb. Joshua Tree's air quality is seriously degraded because the park is located downwind from smog in the Los

Angeles basin.

4.3.5 Visitor Experience

There would be no change to the visitor experience resulting from the no action alternative.

4.4 Environmental Consequences of the Proposed Action

4.4.1 Biotic Communities

Wildlife: In general, habitat components of wildlife species that thrive in pure blackbrush may suffer from the implementation of the proposed action. However, the proposal is to treat up to 65 acres; this represents much less than 0.01% of the total blackbrush habitat in the region. Although reductions of some species that are dependent upon dense plant conditions may occur, these species would not be eliminated by the implementation of the proposed action. Areas that are subjected to planned treatments would continue to meet a portion if not a majority of the habitat needs of the species indicated above that require these conditions. Large areas would be left untreated; thereby leaving remnant vegetative cover that continues to meet cover requirements of these species.

Wildlife species that benefit from a variety of vegetation types and/or less dense stands of blackbrush would clearly benefit from the proposed action. These species include but are not limited to mule deer, some species of passerine birds, Gambel quail, cottontail rabbit, gray fox, bobcat, and ringtail cat. The proposed action would create wildlife habitat diversity by opening up and releasing dense stands of blackbrush and providing suitable growing conditions for native understory grasses, forbs and shrubs.

In addition, some mortality to small mammals and reptiles would occur from the use of herbicide and/or prescribed fire, and associated surface disturbance. This impact is negligible due to the small size of the project and the mitigation measures designed to protect wildlife species.

Vegetation: Direct impacts to vegetation would consist of the removal of the majority of blackbrush plants within the treatment areas. Regeneration is expected to occur under natural conditions. Regeneration would occur in protected microsites with mineral soil seedbeds (that exclude ground fire and protect seedlings from competition with grasses).

Indirect impacts to understory grass species are expected to occur. Sackett et al. (1995) report that grass species respond to prescribed fires and wildfires differently as noted throughout the literature. Galleta resprouts from rhizomes following fire. It is described as a fire tolerant species. After winter burns conducted when soil moisture was sufficient, it yielded 75 percent as much forage the first growing season as an unburned control. A study in north-central Arizona showed that galleta was only slightly harmed by fire and had mostly recovered within 2 years after the burn. With repeat burns, galleta may spread at the expense of other shrubs. Use of prescribed fire as a component of ecosystem restoration may cause short term decrease in herbage production of some species but long term would cause increases in production and abundance.

Direct impacts to vegetation due to a disturbance invader species may occur as well. Nearby unseeded wildfires typically result in red brome/snakeweed communities. With the threat of frequent wildfires, blackbrush may not return to burned sites.

Direct impacts to sagebrush, often a prevalent understory shrub would occur. Sagebrush would not be excluded from prescribed fire. It is believed that sagebrush may be reduced in the short term from prescribed fire and potentially in the long term as well if native grass species return to or increase in areas previously dominated by sagebrush.

All changes in vegetation species abundance, density, and diversity would be monitored on the vegetation and fuels monitoring plots that have been established by USGS throughout the treatment and control areas. Indirect impacts to vegetation (further removed in time

from the action itself) would result in increased native vegetation species diversity and density in all areas.

Conclusion: If the preferred alternative were to be implemented, there would be negligible, adverse, short-term and long-term impacts to biotic communities. Some habitat would be lost as a result of research activities, even with the mitigation of vegetative rehabilitation. The current trend is for portions of the area in and around the site to burn every few years. The relatively small size of the plots in relation to the size of the recent fires and remaining intact blackbrush community indicate that the proposal would not have a significant impact on vegetation. Any increase in annual invasive grasses would reflect the trend that is currently observed in the blackbrush community. The decision of the responsible NPS manager is that there would be no impairment of critical park biotic communities resources resulting from the proposed action.

4.4.2 Species of Special Concern – Desert Tortoise

There are no live tortoises or recent tortoise sign immediately within the area that would be impacted by experimental burns, herbicide, or blackbrush thinning treatments. The burrows found within the SE section of the experimental plots and within the 1200 ft. buffer zone are approximately 3 years or older. The disarticulated skeleton found within the experimental plots appears to have been brought in by a predator since only a portion of the remains was present in place. Thorough surveys covering a 50 ft. perimeter around all tortoise sign found in this survey resulted in no more recent evidence.

This project would occur in desert tortoise habitat east and northeast, respectively, of the Los Angeles and Palm Springs metropolitan areas. Additionally, the project would occur on a literal island of potential tortoise habitat in an increasingly urbanized area of the Morongo Basin. The development of these private lands and the associated loss and degradation of tortoise habitat is expected to continue. However, the impacts to the small (potentially non-existent) tortoise population in the Lower Covington Flats area would have a negligible effect on the Mojave Desert population of tortoises, when total tortoise population numbers, comparative quality of habitat, and geographical extent are considered.

4.4.3 Cultural Resources

There would be no direct impacts to cultural resources from implementing the proposed action. However, due to the proximity of CA-SBR-7651H to the project area, an archeologist would need to flag the boundaries of the site prior to any activity and the site would need to be avoided during all activity in the project area. Flagging would be removed at the conclusion of the project. All important data have been recovered from the four isolated artifacts noted within the project area (Hinton 2003) and they need not be considered during project operations.

There would be no cumulative impacts to cultural resources from implementing the proposed action. However, an archeologist would need to flag the boundaries of the site prior to any activity and the site would need to be avoided during all phases of work in the project area.

There would be no direct or indirect impacts to any significant cultural resources as a result of the preferred alternative if CA-SBR-7651H were flagged and avoided during project activities. There would be no impairment to park resources necessary to fulfill specific purposes identified in the park's enabling legislation or key to the cultural integrity of the park.

4.4.4 Air Quality

There would be a release of smoke during the burning of the plots during the spring and summer burn treatments. Due to the small acreage being burned, the smoke is anticipated to be generally imperceptible to populations in the town of Joshua Tree or Yucca Valley.

The smoke would dissipate quickly due to prevailing winds from the southeast. The proposed action would not cause air quality thresholds for the Mojave Air Quality Management District to be exceeded.

4.4.5 Visitor Experience

Visual impacts of burn/treatment sites: The broader area has received wildfires repeatedly over the years. The proposed action would replicate the burning that has occurred and would blend into the immediate surroundings. The additional management activities at the site, such as placing markers or flagging, would not significantly affect the scene.

Smoke impacts on air quality: Prior to initiating any burning NPS would seek and receive a permit from the Mojave Air Quality Management District. This permit would be issued only if the cumulative effect of the project and all other air quality degrading sources was sufficiently low as to meet state and federal air quality guidelines.

Visitation contemporaneous with firing operations: Visitors could observe smoke from fires burning in the treatment sites. This could result in concerns from the public about threats to Park resources. Public access to the study area would be restricted during all firing operations. Firing operations would total 1-5 days, depending on weather conditions and safety considerations. Public notification would be through the media sources consistent with established procedures.

Trails in the Covington Flats area of the park would be closed for the duration of the study fires. The remaining 270 miles of trails and trail corridors within the park would remain open during the proposed action.

The short-term effect to visitor experience of the proposed action would be adverse and moderate in intensity. Any long-term effects to visitor experience would be negligible, as the burn study plots have been designed to blend in with the existing burn scars from recent wildland fires.

5 Consultation and Coordination

5.1 Preparers and Reviewers

The following National Park Service employees participated in the completion of this environmental assessment either through assistance in preparation, consultation, or in review of the draft document:

Fire Management Officer Tom Patterson

Resources Management Division Chief Hank McCutchen

Vegetation Specialist Jane Rodgers

Branch Chief of Cultural Resources Jan Sabala

Archeological Technician Sarah Hinton

Visual Information Specialist Sandra Kaye

The following US Geological Survey, Biological Resources Division personnel participated in the completion this environmental assessment either through assistance in preparation, consultation, or in review of this document:

Dr. Matt Brooks

Todd Esque

JR Matchett

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7 Attachments

7.1 Study Plan

Fire Behavior, Fire Effects, and Fuel Management in Blackbrush (*Coleogyne ramosissima*) Shrublands and Invasive Annual Grasslands of the Mojave Desert

STUDY PLAN 20 May, 2003

Matt Brooks[1], Todd Esque[2], Tim Duck[3], and Tom Patterson[4]
[1]Research Botanist, United States Geological Survey, Biological Resources Division, Western Ecological Research Center, Las Vegas Field Station, 160 N. Stephanie Rd. Henderson NV 89074, matt_brooks@usgs.gov; phone 702-564-4615; fax 702-564-4600
[2]Ecologist, United States Geological Survey, Biological Resources Division, Western Ecological Research Center, Las Vegas Field Station
[3]Ecologist, Bureau of Land Management, Parashant National Monument
[4]Interagency Fire Management Officer, National Park Service, Joshua Tree National Park

SUPPORTING AGENCIES
Funding for Research and Monitoring
DOI/USDA, Joint Fire Science Program (JFS)
NPS, Pacific West Region, Fire Program (NPS-PWR)
USGS-NPS Park Oriented Biological Support program (USGS/NPS)
In-kind Operational Support
BLM, Arizona Strip Field Office
BLM, California Desert District
BLM, Parashant National Monument
BLM, St. George Field Office
NPS, Joshua Tree National Park
NPS, Mojave National Preserve

COOPERATORS
Bureau of Land Management
Jim Crisp, Field Office Manager, St. George Field Office
Richard Franklin, Regional Fire and Aviation Management Officer, California Desert, BLM/NPS
Hilary Boyd, Fire Ecologist, Arizona Strip Field Office

National Park Service
Judy Bartzatt, Chief Ranger, Joshua Tree National Park
Curt Deuser, Natural Resource Specialist, Lake Mead National Recreation Area
Kristy MacMillan, Interagency Fire Management Officer, Mojave National Preserve NPS and the BLM Needles Field Office
Hank McCutchen, Chief of Resource Management, Joshua Tree National Park
Jane Rogers, Botanist, Joshua Tree National Park

JUSTIFICATION

The Federal Wildland Fire Management Policy defines fire as a critical natural process that should be reintroduced for the benefit of ecosystem integrity (Glickman and Babbitt 1995). It also recognizes fire hazards that can result as fuels accumulate where fire has been previously suppressed and recommends that fire be used to reduce these high fuel loads. However, in some ecosystems fire may not be a natural ecosystem component or an appropriate tool to reduce fuel loads. One such ecosystem may be the Mojave Desert, where fire appears to be historically rare (R. Minnich unpublished data, NPS and BLM records), plant communities are generally slow to recover from fire (O'Leary and Minnich 1981, Brown and Minnich 1986, M. Brooks unpublished data), and recent increases in fire frequency appear to have increased landscape flammability by promoting the postfire

dominance of invasive annual grasses (Brooks 1999). These observations are based on limited data, but they indicate that fire may have mostly negative effects in the Mojave Desert. Additional studies are needed to determine if fire is an appropriate and useful tool for land managers. This information is a critical component that is lacking in existing fire and resource management plans in this region.

The frequency of fire and the size of human populations increased recently in the Mojave Desert, and fire is now a threat to both homes and wildlands in some areas. Land managers need tools to reduce the chance of fire spreading from wildlands into urban areas, and from urban areas, campgrounds, and roadsides into wildlands. Although most desert plant communities do not burn easily, those dominated by blackbrush (Coleogyne ramosissima), invasive annual grasses, or especially those dominated by both, can fuel very large fires. Prescribed fire has been used to reduce woody fuels from blackbrush, but the profusion of fine fuels from invasive annual grasses that typically follow create a new fire hazard and other threats to ecosystem integrity. Management tools are needed to reduce existing fire hazards, but not create new hazards or threaten natural resources. This study will document the behavior and ecological effects of fire, and evaluate the use of fire and mechanical thinning to reduce woody fuel loads from blackbrush, and fire and herbicides to reduce fine fuel loads from invasive annual grasses. Differences in perennial plants, annual plants, soil seedbanks, and soil nutrients will be compared among fire and fuel management treatments to evaluate their relative ecological effects.

BACKGROUND

Blackbrush can produce the most continuous cover of any perennial shrub in the Mojave Desert, and it is one of the few vegetation types that can carry fire and create complete burns without substantial fine fuel loads (Bowns 1973). It has a compact growth form with many senescent terminal buds that increase its ability to burn. It is considered to be one of the most flammable native vegetation type in this region, and as such is a potential fire hazard, especially where invasive annual grasses are also present and where ignition sources are frequent at the interface between urban and wildland areas and in areas of high lightning occurrence. One example is at Joshua Tree National Park, where blackbrush scrub intermixed with invasive annual grassland has recently fueled large fires that threaten the neighboring community of Yucca Valley. After blackbrush burns, the profusion of invasive annual grasses that often occurs creates additional fire hazards. Other areas in the eastern and northeastern Mojave Desert are experiencing similar problems with fire in blackbrush vegetation and the invasive annual grasslands that dominate postfire landscapes.

Although blackbrush can carry fire, historic fire return intervals were probably very long because stands are typically found on old undisturbed sites (Webb et al. 1987) and they are slow to reinvade burned areas, especially on shallow soils with low soil moisture (Bowns 1973, Bates 1984). Blackbrush is considered a relictual endemic of arid and semi-arid western North America (Stebbins and Major 1965), and very old stands that established hundreds to thousands of years ago may not be able to reestablish in the recent climate of increasing fire frequency. Disjunct populations in the southwestern part of its range may be especially endangered due to their relatively small size (e.g. at Joshua Tree National Park).

Fire Behavior

There is a debate over which vegetation type constitutes the greater fire threat: blackbrush because it appears to burn more intensely, or the vegetation type that often replaces blackbrush after it burns, invasive annual grassland, because it appears to ignite easily and promote a higher rate of fire spread. The behavior of fire in these plant communities has not yet been evaluated, and one objective of our study is to compare fire intensities and spread rates in these two fuel types. We will evaluate fire behavior during spring and summer, two seasons with contrasting weather and fuel conditions. These analyses are

necessary to accurately evaluate fire hazards and weigh the benefits of fuel management treatments to reduce these hazards against the potential negative ecological effects caused by the treatments. These data will be used to help develop custom fuel models that can be use to predict fire behavior in blackbrush and invasive annual grasslands.

Methods to Reduce Fuel Loads in Blackbrush

Prescribed fire has been used to reduce the cover of blackbrush, because it is easily killed by fire and doesn't recover even after 40 years (Callison et al 1985). Reestablishment of blackbrush stands after fire have not been documented, largely because recovery times are so long, possibly on the order of centuries. Burned blackbrush can be replaced by annual plants during the first few postfire years, then by perennial grasses that can dominate for decades (Bates 1984, Brooks and Matchett in press). However, this pattern is highly variable (Bowns 1973, Wright and Bailey 1982, Callison et al. 1985, Brooks and Matchett in press), and invasive annual grasses dominate areas of burned blackbrush at Joshua Tree National Park (DOI unpublished data, Brooks and Matchett in press) and at sites in the northeastern (Jensen et al. 1960, Rickard and Beatley 1966, Brooks and Matchett in press) and northwestern Mojave Desert (Bates 1984), creating a new type of fire hazard from flashy fuels that promote recurrent burning (Whisenant 1990, Brooks 1999). Recurrent fire promotes the dominance of invasive annual grasses, and their competition with native plants for soil nutrients and water threaten native plant communities and the wildlife species that depend on them.

Mechanical control methods have also been use to reduce blackbrush cover and promote the production of more palatable livestock forage, and there is some indication that these methods may also reduce fire hazards. Chaining, cabling, and brush beating of blackbrush can shred flammable dead woody material and promote the regrowth of new less flammable live shoots without appreciably promoting the dominance of early successional species (Bowns 1973). Grazing by goats has also been used to reduce dry stem biomass and promote the regrowth of more succulent live shoots (Provenza et al. 1983). However, these mechanical methods for fuel reduction cause high levels of soil disturbance which may produce other undesirable ecological effects such as damage to cultural resources and promoting the growth of invasive plant species.

Methods to Reduce Fuel Loads in Invasive Annual Grasslands

Desert fires can be used to manage invasive annual grasses, but their short-term effects can be highly variable. For example, during the first few postfire years density and biomass of either *Bromus rubens* or *Bromus tectorum* decreased in burned compared to unburned sites in the Mojave (Baldwin 1979, Brooks 2002), Sonoran (Cave 1982, Cave and Patten 1984), and Great Basin deserts (Hassan and West 1986, Rasmussen 1994), but these species or *Schismus* spp. also increased at burned sites in the Mojave (Brooks 2002), Sonoran (Loftin 1987), and Great Basin deserts (West and Hassan 1985). Fires that occur before *Bromus tectorum* seeds disperse to the ground can reduce densities 400 to 1,000% during the following spring (Pechanec and Hull 1945) because seeds suspended above-ground within inflorescences are more susceptible to lethal temperatures than seeds located on or beneath the soil surface (Rasmussen 1994). Regardless of what happens during the first few postfire years, *Bromus rubens* and *Bromus tectorum* typically return to or exceed prefire dominance during subsequent years in the Mojave (Beatley 1966, Hunter 1991, Brooks in press), Sonoran (Tratz 1978, Brown 1984), and Great Basin deserts (Callison et al. 1985, Rasmussen 1994). These results indicate that fire can be used to temporarily reduce the dominance of invasive grasses, but in the longterm fire may actually increase their dominance. Environmental conditions, fuel characteristics, fire behavior, and plant phenology during fires must be documented and the effects of fires must be monitored to accurately evaluate their effects and develop effective burn prescriptions for the control of invasive annual grasses, or to determine if such prescriptions even exist.

Postfire dominance of invasive annual grasses appears to be strongly affected by changes

in nutrient availability caused by fire (Giovannini et al. 1990). These mechanisms must be understood to predict potential invasion patterns and develop techniques to restore invaded ecosystems (Crawley 1987). In addition, there exist theoretical temperature thresholds below and above which fire-induced soil fertility changes should not promote postfire dominance of invasive annual grasses. Fire prescriptions targeted for these zones may minimize the postfire dominance of these grasses.

Herbicides have been used to control invasive grasses and to reduce fine fuel loads, but collateral effects on non-target plants may occur. Atrazine (Aatrex®) can reduce biomass of *Bromus* (Evans and Young 1977, Currie et al. 1987), but its negative effects on native plants can persist for at least 8 years (Hunter et al. 1978). Sulfomethuron methyl (Oust®) can reduce biomass of *Bromus tectorum*, but collateral damage can occur to native perennials at doses as low as 1oz/acre (Pellant et al. 1999). Fluazifop-p-butyl (Fusilade®) can be used to control annual and perennial grasses, and at low doses can be used to selectively kill annual species. However, the use of all these herbicides are restricted in some states (especially California) and they can be expensive.

Glyphosate (Roundup®) is widely used to control invasive weeds and is one of the least expensive most widely tested herbicides available. It can control *Bromus tectorum* at application rates of 2.6-2.9 oz/acre (Blackshaw 1991) and 5.9-8.0 oz/acre (Beck et al. 1995), and *Bromus rubens* at rates of 12 oz/acre (Larry Jensen, Helena Chemical Company, personal communication) with minimal collateral affects on native perennials. Rates above 16 oz/acre often damage and may kill non-target perennial plants, according to the manufacturer (Monsanto). We plan to use glyphosate at an application rate of 10oz/acre in this study. This concentration should be high enough to kill invasive annual grasses and reduce fine fuel loads, but low enough to only partially defoliate native perennial plants that may also occur in previously burned areas.

Ecological Effects of Fire and Fuel Treatments

The ecological side effects of each fire and fuel management treatment must be monitored, along with the effectiveness of each treatment in achieving its desired goal, to evaluate the relative merits of each treatment. Responses of plant populations and communities, soil seedbanks, and soil nutrient levels will be monitored in this study. These ecological data will be coupled with fuel, weather, fire behavior, and fire temperature data to develop a predictive model that land managers can use to predict the potential ecological effects of fire given specific conditions during burning.

OBJECTIVES

(primary funding sources for each listed in parentheses)

Compare fire behavior of blackbrush and invasive annual grassland vegetation and gather data to help develop custom fuel models for these vegetation types. (NPS-PWR, USGS/NPS)

Prediction: Fire will have a higher rate of spread in invasive annual grassland, but have a higher intensity in blackbrush vegetation.

Evaluate the effects of spring fire, summer fire, and blackbrush thinning on post-treatment fuel loads. (NPS-PWR)

Prediction: Cover and biomass of woody fuels will decrease and cover and biomass of fine fuels will increase after treatments.

Evaluate the effects of spring fire, summer fire, and herbicide treatments on post-treatment dominance of invasive annual grasses. (JFS)

Prediction: Cover of invasive annual grasses will be lower after spring fires and after herbicide treatments compared to summer fires or untreated controls.

Document the ecological effects of a short fire-return interval. (NPS-PWR, USGS/NPS)

Prediction: Native annual and perennial plant cover and diversity will be lower, and cover of invasive annual grasses will be higher in plots that burned within 10 years before experimental fires than in plots with no evidence of burning before experimental fires.

Document the ecological effects of spring fire, summer fire, blackbrush thinning, and herbicide application on plant populations and communities, and on soil nutrient levels (NPS-PWR, USGS/NPS)

Compare the cost-effectiveness of spring burning versus herbicide applications for reducing fine fuel loads and controlling invasive annual grasses. (JFS)

Develop a biophysical model describing the relationships between burning conditions and postfire effects on vegetation, soil seedbanks, and soil nutrient levels. (NPS-PWR, USGS/NPS)

Develop educational materials and establish the three field sites as demonstration sites of the effects of alternative management treatments for the reduction of fuel loads and the control of invasive annual grasses. (JFS)

Develop a long-term monitoring protocol to evaluate the effects of treatments over multiple years. (JFS, NPS-PWR)

STUDY SITES

Two study sites will be established at the southwest and northeast ends of the geographic range of blackbrush in the Mojave Desert to represent possible regional variation and to provide information for localized areas where fires are a recognized problem for land managers. Both sites will be located in areas containing unburned blackbrush scrub and burned areas now dominated by invasive annual grassland. Blackbrush scrub will include emergent Joshua tree (*Yucca brevifolia*) and California or Utah juniper (*Juniperus californica* or *Juniperus osteosperma*) with invasive annual grasses in the interspaces between shrubs. We chose this species composition because it is common throughout the region, it is typical of the urban-wildland interface at places like Joshua Tree National Park, and the arborescent species add to the overall fire hazard. California junipers increase the intensity and Joshua trees increase the spotting potential of fires. The invasive annual grassland in this study will be dominated by the invasive annual grasses *Bromus rubens* and/or *Bromus tectorum*, and early successional woody shrubs, bunchgrasses, and herbaceous perennials.

The nolina cove area of Joshua Tree National Park is located in the southwest Mojave Desert in California. During the past few decades fires have been very frequent, and some have been very large (>13,000 acres) in this area. The invasive annual grassland at this site was created after a prescribed burn administered by NPS in 1993 (Nolina III prescribed burn). Soils at the Joshua Tree location are sandy loams derived from alluvial granitic parent materials, with no apparent petrocalcic horizons near the surface (Brooks personal observation).

The beaver dam slope in the Bureau of Land Management, St. George Field Office, is located in the northeastern Mojave Desert. Fires have recently been very frequent in this region and have destroyed vast expanses of vegetation dominated by blackbrush, creosotebush, and Joshua trees. The invasive annual grassland at this site was created after a wildfire in 1995. Soils are classified as Cave gravelly sandy loams, which occur on dissected, old, coalescing alluvial fans or bajadas, with a petrocalcic horizon ranging from 20 to 51 cm below the surface (Mortensen et al. 1977). Parent materials are mixed gravelly alluvium from weathered gneiss, limestone, dolomite, quartzite, shale, and acid igneous rocks.

METHODS

This study is within the range of a federally threatened species, the desert tortoise (*Gopherus agassizii*), although tortoise densities are usually low in blackbrush vegetation.

Wildlife biologists will conduct 100% surface surveys at the sites before burning to ensure that no tortoises or other sensitive species are present. If tortoises are present on the study sites, then personnel certified by the United States Fish and Wildlife Service will relocate them to adjacent sites away from the burn plots and fire equipment. Resource management personnel from NPS, BLM, and USFS will conduct the environmental assessment and help obtain clearances. We previously conducted similar experimental fires in the Mojave Desert which requires a proposed study from the United States Fish and Wildlife Service through a Section 7 consultation. Additional guidelines may be required by the Fish and Wildlife Service through their Biological Opinion for this project.

Experimental Treatments

Treatments will be applied to 4 replicate 1ha plots in each vegetation type at each site (Table 1). A total of 8ha will be burned in spring, 8 ha will be burned in summer, 4ha will have blackbrush stems thinned by 50%, 4ha will have herbicide applied to annual grasses, and 8ha will be left untreated. These plots will be large enough to document fire behavior and allow us to evaluate the treatment at multiple spatial scales within each treatment plot. Remnants of old fire breaks, dirt roads, and a 10m blackline around each treatment plot will prevent the experimental fires from escaping and becoming wildfires. The blacklines will be created by burning out all fuels using a drip-torch when fire hazard is low during late winter 2003 or early spring 2004. Fire personnel from the BLM and NPS will prep the sites and conduct the fires.

Fire treatments will be applied in spring (May or June) and summer (July, August, or September). The fires will be started by igniting all vegetation in parallel strips along the upwind border of each plot with a drip-torch, and letting it spread as a headfire through the fire treatment plot. Each fire will be allowed to extinguish naturally on its own within each treatment plot, but the spread of fire outside of the plots will be prevented by fire crews using hand tools, water, or foam at the discretion of the burn boss.

Blackbrush thinning in the unburned blackbrush will be applied during Winter or Spring, and will consist of the systematic removal of the above-ground biomass from every other blackbrush individual (50%) in the treatment plot. Members of the hand crew will line up 3m apart and proceed across the treatment plot parallel to the plot edge, removing every other blackbrush plant they encounter. The hand crew will continue this process in non-overlapping passes until the entire plot has been covered. Blackbrush plants will be "grubbed out" by cutting them at the root crown with a Pulaski axe or a chainsaw during the initial passes through the plots. The hand crew will then retrace their initial passes, this time picking up the cut shrubs to remove them from the plot. Removed woody materials will either be placed in a plant chipper and spread outside of the plot, or piled and burned outside of the plot.

Herbicide treatments in the invasive annual grassland will be applied once during Spring. Glyphosate (RoundUp®) herbicide will be applied at 10oz/acre. Spray crews will line up and make passes through the plot in a similar way as described above for the blackbrush thinning.

Table 1. Experimental treatments at each site (n=4 replicate 1ha plots of each combination of treatment and vegetation type).

Experimental Treatments	Unburned Blackbrush	Invasive Annual Grassland	# of 1ha plots (total area in ha)
Spring burn	yes	yes	8
Summer burn	yes	yes	8
Shrub Thinning	yes	no	4
Herbicide	no	yes	4
Untreated control	yes	yes	8
# of 1ha plots	16	16	

Sampling Design

Physical variables. Prior to the fires, weather conditions will be recorded for 48 hours, fuel moisture will be estimated for herbaceous and woody fuels, and fuel loads will be measured in random clip-plots. Fuel loads will be estimated by sampling fine and woody fuels, and developing regression equations relating cover to each fuel class with biomass. Fuel moisture will also be calculated for each fuel class as the percent difference between their pre and post oven-dried weight. During the fires, air temperature, relative humidity, and wind speed will be recorded. To document fire behavior within each treatment combination, fireline intensity will be estimated by documenting flame length and rate of spread at replicate locations, and by recording with a digital video camera. Digital images will be processed later using software to precisely quantify fire behavior.

Temperatures will be monitored in a 2 x 5 array of sampling stations located adjacent to each mod-whit plot (Fig. 1). Each station will be 25m^2 and contain two sampling points, in the beneath-canopy and interspace microhabitats. Temperatures will be monitored separately in these two microhabitats, at 15cm, 0cm, and −2cm from the soil surface using thermocouples connected to data loggers.

Fuel and weather conditions, and fire behavior observations, will be correlated with temperature measurements associated changes in vegetation, soil seedbanks, and soil nutrient levels to develop an initial predictive model for fire managers to use in predicting the potential ecological effects of fire given specific fuel, weather, and fire behavior variables.

Biological variables. Plant cover and species richness will be measured using the modified-Whittaker nested sampling method (Stohlgren et al. 1995). This method allows us to evaluate treatment effects at multiple spatial scales. One 20 x 50m (100 m^2) sampling plot will be established within each of the 32 treatment plots. The basic sampling units within each 100m^2 sampling plot will be ten 1m^2 (0.5 x 2m) subplots where annual and perennial plant cover will be estimated using the Braun-Blanquet index (Greig-Smith 1964). Cover estimates will include live annual plants identified to species, and dead annual plants as invasive annual grasses, invasive forbs, and native forbs. Species richness will be recorded as the total number of plant species present in the live standing crop at 1, 10, 100 and 1,000m^2 scales. We will also measure species richness by growing out soil seedbank samples collected from soil cores (3cm deep) adjacent to each of the 1m^2 cover plots within each 100m^2 sampling plot. This will allow us to compare the reliability of these two sampling methods for future studies. Sampling the seedbank will also ensure a valid estimation of species diversity in case low rainfall leads to limited germination.

Immediate fire effects on soil nutrient composition and seedbank mortality will be measured from soil cores (3cm deep) located at each of the 20 sampling points in each treatment plot (10 sampling stations x 2 sampling points/station). Samples collected immediately before and after the fires will be used to estimate changes in seedbank density and species composition and soil nutrient availability, caused by fire. We will measure soil NO_3, NH_4, total Kjeldahl N, Olsen-P, pH, $CaCO_3$, and soil texture. Longer-term fire effects on seedbanks will be monitored at the ten 1m^2 subplots in each mod-whit plot.

Data Analyses

Treatments will be applied in a fixed effect, randomized design (Steele and Torrie 1980). Analysis of variance will be used to evaluate the differences between the main and interaction effects of treatment [spring fire, summer fire, blackbrush thinning (in blackbrush)/herbicide application (in annual grassland), control] and vegetation type (blackbrush, annual grassland). The two study sites will be analyzed independently, with 4 replicates of each treatment x vegetation combination within each site. Appropriate error terms will be used for tests of statistical significance ($P \leq 0.05$).

RESEARCH SCHEDULE

FY00

Develop study plan

Identify study areas

Purchase equipment

FY01 and FY02 (treatments delayed until FY03 due to drought)

Establish experimental plots at Joshua Tree National Park and on the Beaver Dam Slope of the St. George Field Office BLM, in alien annual grassland (previously burned blackbrush) and unburned blackbrush

Collect pre-treatment plant data

Write burn plan and obtain biological and cultural clearances

FY03 (only blackbrush thinning applied this year, other treatments delayed due to drought)~~Apply herbicide treatments in March~~

Collect pre-treatment soil seedbank samples early Fall

Grow out seedbank samples and identify species during Winter

Collect pre-treatment data in Spring

Apply blackbrush thinning in the blackbrush shrubland in Spring

Collect blackbrush fuel samples to develop cover vs. biomass regression models in Spring

At the Beaver Dam site, apply fire treatments in the blackbrush shrubland and document fire behavior and intensity in spring and summer

Analyze pre and post-fire soil nutrients and seedbanks to establish immediate fire effects on nutrient availability and seed viability

FY04 (plan to apply all other treatments if rainfall produces a substantial crop of invasive grasses)

Collect soil seedbank samples (post-treatment blackbrush thinning and control plots; pre-treatment all other plots) early Fall 2003

Grow out seedbank samples and identify species during Winter

Apply herbicide treatments in the invasive annual grassland in Spring

Apply fire treatments in the blackbrush shrubland and document fire behavior and intensity in spring and summer

At the Joshua Tree site, apply fire treatments in the invasive annual grassland and document fire behavior and intensity in spring and summer

Analyze pre and post-fire soil nutrients and seedbanks to establish immediate fire effects on nutrient availability and seed viability

Collect post-treatment (blackbrush thinning and control plots) plant measurements in the early Spring

FY05

Collect post-treatment soil seedbank samples early Fall

Grow out seedbank samples and identify species during Winter

Collect post-treatment plant measurements in the early Spring

FY06

Collect post-treatment soil seedbank samples early Fall

Grow out seedbank samples and identify species during Winter

Collect post-treatment plant measurements in the early Spring

Establish long-term monitoring protocol

Complete final report

PRODUCTS

Baseline comparisons of plant cover and diversity in blackbrush and invasive annual grasslands were reported at the end of FY01, and have been submitted for publication (Brooks, M.L. and J.R. Matchett. In press. Plant community patterns in unburned and burned blackbrush (*Coleogyne ramosissima* Torr.) shrublands in the Mojave Desert. Western North American Naturalist). A similar report will be delivered at the end of FY03, then submitted for publication. Information on fire behavior and the first year effects of fuel management treatments will be reported at the end of the year in which the data are collected (hopefully FY04). Fuel, fire weather, and fire behavior data will be combined to develop custom fuel models by the end of FY05. A final report will be completed by the end of FY2006.

Data will be reported annually to federal land managers in the Mojave Desert and the board of directors of the Joint Fire Science Program. We will also provide tours of the sites, and coordinate a regional workshop on the ecology and management of fire and invasive plants in the Mojave Desert if stakeholders request this (tentatively planned for FY04). We expect to publish approximately 6 journal articles using these data, in addition to fact sheets and press releases that focus on specific management issues. The USGS principal investigators will continue to provide technical assistance on fire management issues for federal land managers in the Mojave Desert.

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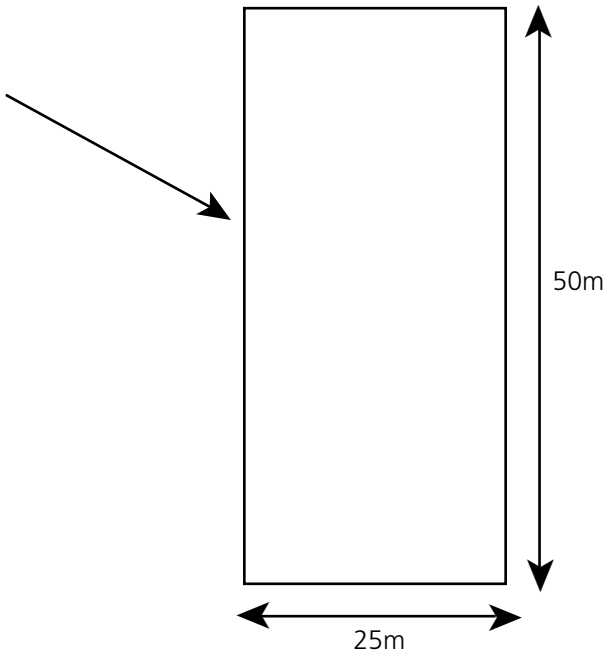
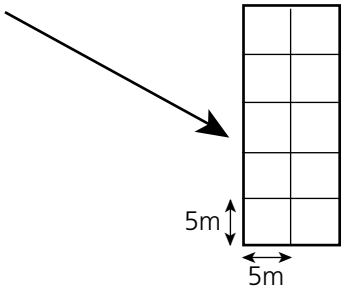
Figure 1

Mod-whit diversity and cover plot

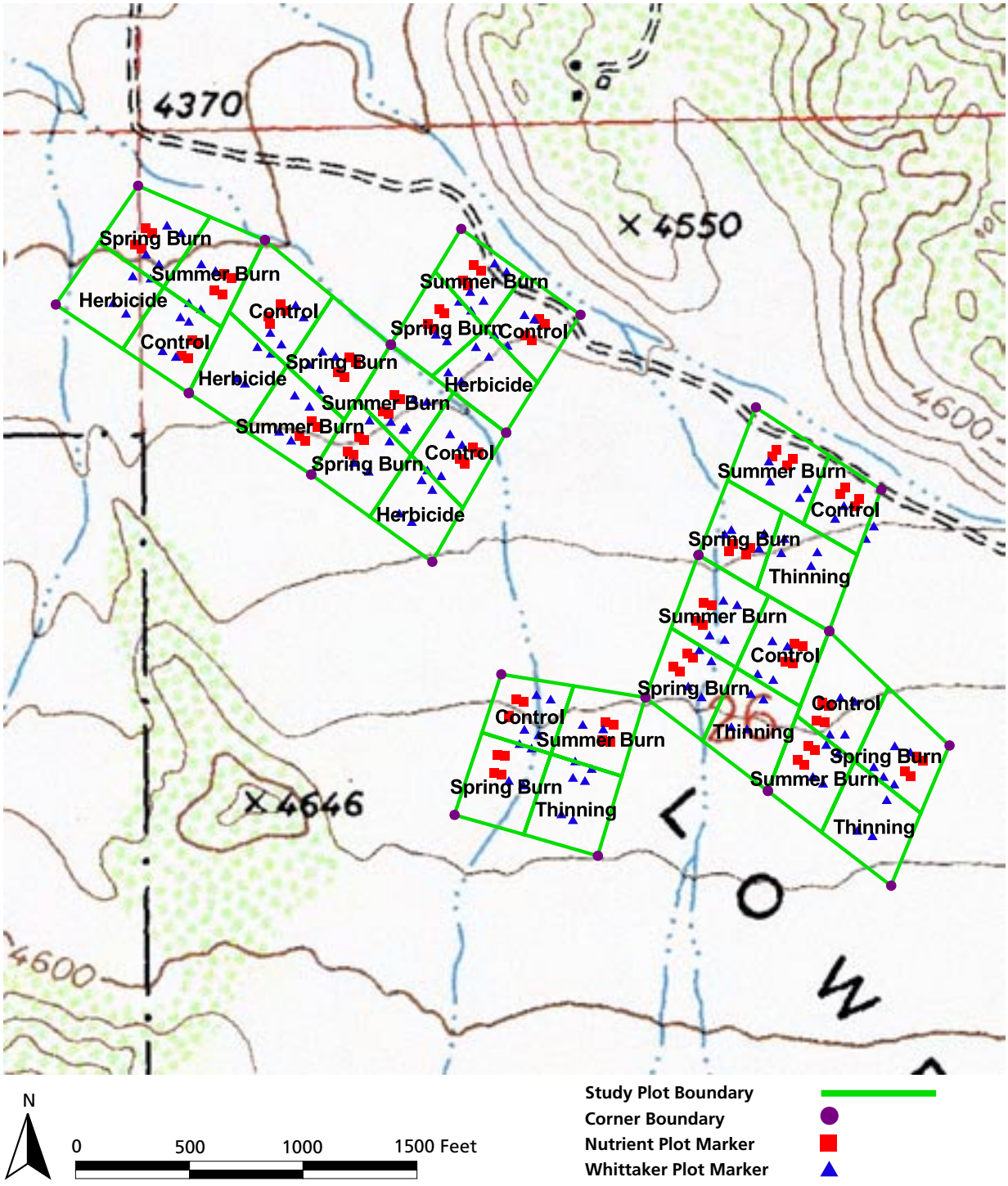


Annual plant biomass, soil seedbank, soil nutrient, and fire temperature plots



8 Figures

8.1 Research Plots



8.2 Vicinity Map